Hacettepe University - Department of Geomatics Engineering

2019-2020 Fall

GMT444–Fundamentals of LaserScanning

LabAssignment–Building Extraction From Lidar Data

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Figures :

REPORT

1. Downloading and Exploring the Data

-For this step , I used lasview.

```
lasview -i "C:\Users\aysim\OneDrive\Masa³st³\Aysima21531925\GMT444_data.laz"
lasview -i "C:\Users\aysim\OneDrive\Masa³st³\Aysima21531925\GMT444_data.laz"
lasview -i "C:\Users\aysim\OneDrive\Masa³st³\Aysima21531925\GMT444_data.laz" -color_by_elevation2
lasview -i "C:\Users\aysim\OneDrive\Masa³st³\Aysima21531925\GMT444_data.laz" -color_by_intensity
lasview -i "C:\Users\aysim\OneDrive\Masa³st³\Aysima21531925\GMT444_data.laz" -only_first
lasview -i "C:\Users\aysim\OneDrive\Masa³st³\Aysima21531925\GMT444_data.laz" -only_first
lasview -i "C:\Users\aysim\OneDrive\Masa³st³\Aysima21531925\GMT444_data.laz" -only_first
computing TIN ... triangulating 85033 points took 0.093 seconds.
```

Figure I -Command line script for first step

Color the point cloud by ;
i)elevation and

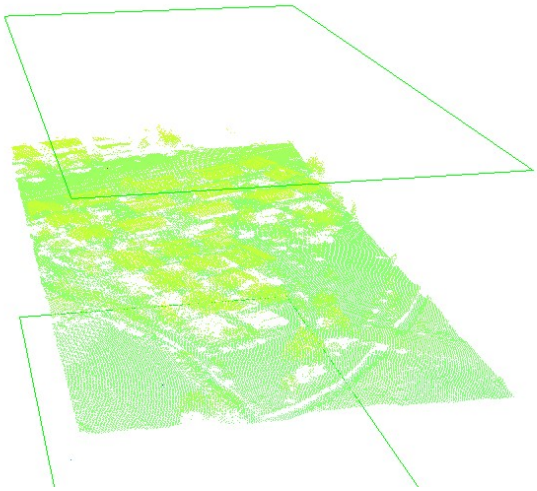

Figure II – Screenshots for color by elevation-2

-color_by_elevation2 : render points by elevation color ramp (blue->yellow->red)

ii)intensity.

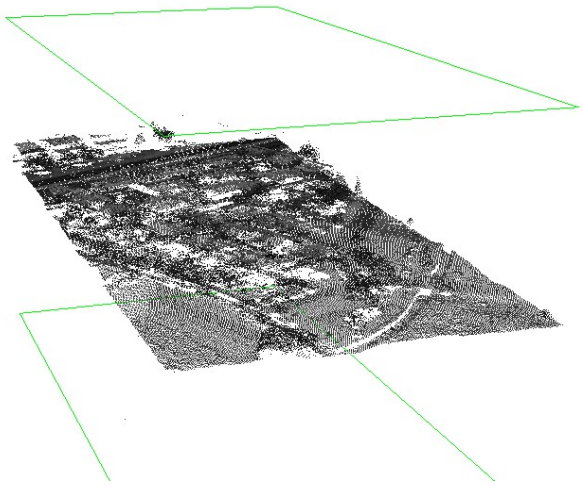

Figure III – Screenshots for color by intensity

-color_by_intensity : render points by intensity

iii)Display only *first returns*, perform *triangulation* and provide a *hill shaded* display.

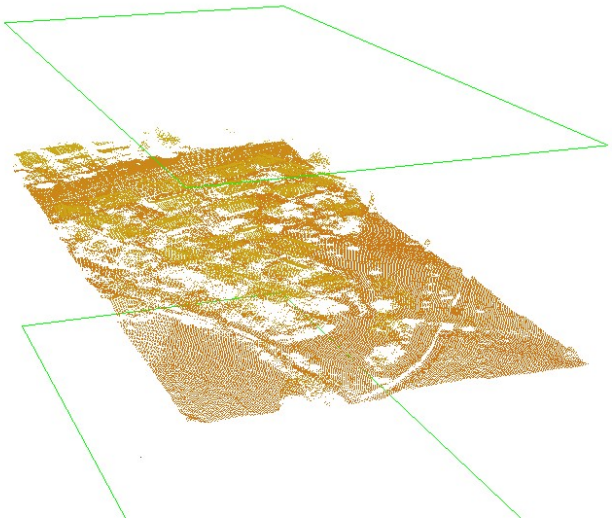

Figure IV – Screenshots for render by first return

-only_first : render only first returns

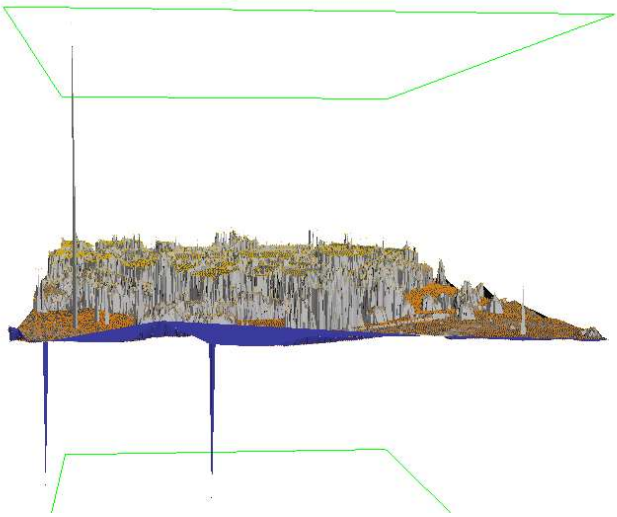

Figure V -Screenshots for triangulation and provide a hillshaded display

-color_by_return : render points by return colors (single = yellow, first of many = red, last of many = blue, intermediate = green)

2. Classification of the Noise Points

-For second step , I used lasnoise

```
lasnoise -i "C:\Users\aysim\OneDrive\Masa³st³\Aysima21531925\GMT444_data.laz" -step_xy 4 -step_z 1 -odir "C:\Users\aysim\OneDrive\Masa³st³\Aysima2153
1925" -o "4_1_5.laz"
done with 'C:\Users\aysim\OneDrive\Masa³st³\Aysima21531925\4_1_5.laz'. took 0.171 sec. classified 93 noise points.
lasnoise -i "C:\Users\aysim\OneDrive\Masa³st³\Aysima21531925\GMT444_data.laz" -step 4 -isolated 20 -odir "C:\Users\aysim\OneDrive\Masa³st³\Aysima2153
1925" -o "4_4_20.laz"
done with 'C:\Users\aysim\OneDrive\Masa³st³\Aysima21531925\4_4_20.laz'. took 0.171 sec. classified 36 noise points.
```

Figure VI - Command line script for second step

-step_xy : set the horizontal x and y spacing of the grid to step_xy input value.
-step_z : set the vertical z spacing of the grid to step_z input value.
-isolated : points are isolated when there is a total of less than isolated input value points in all neighbour cells

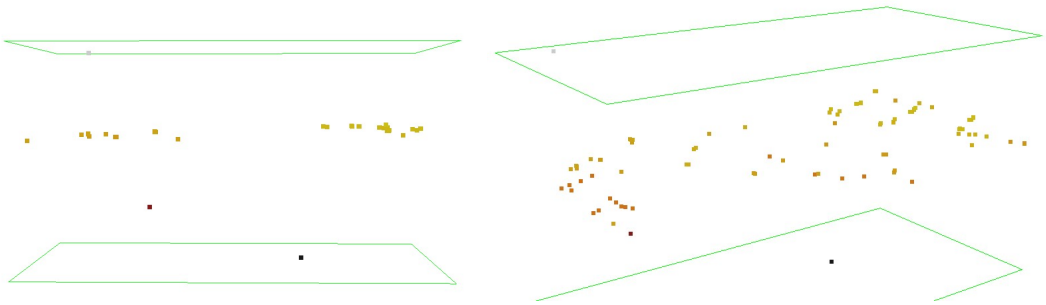

Figure VII -Screenshots for second question with the following parameters :
-step_xy : 4
-step_z : 4
-isolated : 20

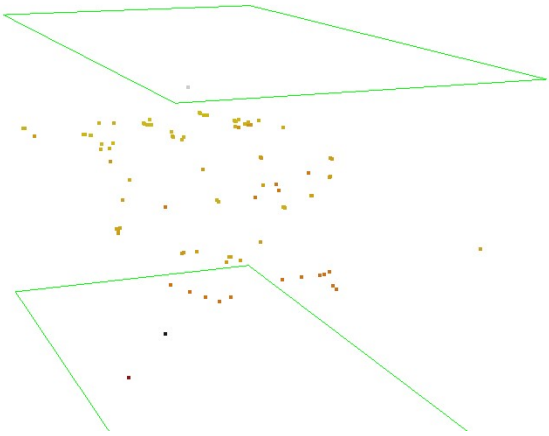

Figure VIII -Screenshots for second question with the following parameters :
-step_xy : 4
-step_z : 1
-isolated : 5

3. Ground Filtering

-For third step , I used lasground

```
lasground_new -i "C:\Users\aysim\OneDrive\Masaᵌstᵌ\Aysima21531925\4_1_5.laz" -city -ignore_class 7 -compute_height -odi
 "C:\Users\aysim\OneDrive\Masaᵌstᵌ\Aysima21531925" -o "grounf_fil.laz"
done with 'C:\Users\aysim\OneDrive\Masaᵌstᵌ\Aysima21531925\grounf_fil.laz'. total time 0.64 sec.
```

Figure IX - Command line script for third step

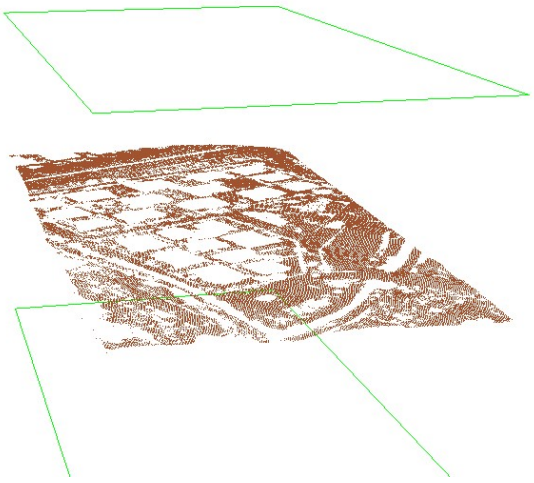

Figure X – Screenshots for ground filtering

The tool also produces excellent results for town or cities but buildings larger than the step size can be problematic. The default step size is 5 meters, which is good for forest or mountains. For towns or flat

terrains '-town' the step size is increased to 10 meters. For city or warehouses '-city' the step size is increased to 25 meters. Fort his point cloud , I choose city or warehouses option.

4. Classification of buildings and vegetation

-For fourth step, I used lasclassify.

```
lasclassify -i "C:\Users\aysim\OneDrive\Masa³st³\Aysima21531925\grounf_fil.laz" -odir "C:\Users\aysim\OneDrive\Masa³st³
Aysima21531925" -o "21531925_classified.las"
done with 'C:\Users\aysim\OneDrive\Masa³st³\Aysima21531925\21531925_classified.las'. total time 0.749 sec.
```

Figure XI -Command line script for fourth step

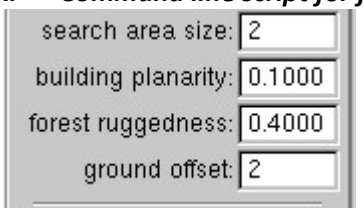

Figure XII -Parameters for classify

Search area size : grid cell size for planar / non-planar analysis
Ground offset : only points that are 2 (my choice) meters above ground are considered
Building planarity : grid cell points up to this standard deviation are potential roofs
Forest ruggedness : grid cell points above this standard deviation are potential vegetation

5. DTM generation

-For fifth step, I used las2dem

What is a Digital Terrain Model (DTM) ?

a digital terrain model (DTM) actually has two definitions depending on where you live.

• In some countries, a DTM is actually synonymous with a DEM. This means that a DTM is simply an elevation surface representing the bare earth referenced to a common vertical datum.

• In the United States and other countries, a DTM has a slight different meaning. A DTM is a vector data set composed of regularly spaced points and natural features such as ridges and breaklines. A DTM augments a DEM by including linear features of the bare-earth terrain.

```
las2dem -i "C:\Users\aysim\OneDrive\Masa³st³\Aysima21531925\21531925_classified.las" -keep_classification 2 -step 0.5 -elevation
 -odir "C:\Users\aysim\OneDrive\Masa³st³\Aysima21531925" -o "2_21531925.tif"
```

Figure XIII -Command line scripts for fifth step

Figure XIV -Digital Terrain Model Screenshots

-kill triangles 100 : do not raster triangles with edges longer than 100 meters

6. DSM generation

For sixth step,I used las2dem.

What is a Digital Surface Model (DSM) ?
Digital Surface Model (surface elevation, including trees, buildings, houses, etc)
In a LiDAR system, pulses of light travel to the ground. When the pulse of light bounces off its target and returns to the sensor, it gives the range (a variable distance) to the Earth. Hence, how this system earned its name of Light Detection and Ranging. In the end, LiDAR delivers a massive point cloud filled of varying elevation values. But height can come from the top of buildings, tree canopy, powerlines and other features. A DSM captures the natural and built features on the Earth's surface.

```
las2dem -i "C:\Users\aysim\OneDrive\Masa³st³\Aysima21531925\21531925_classified.las" -first_only -drop_classification 7
-step 0.5 -elevation -odir "C:\Users\aysim\OneDrive\Masa³st³\Aysima21531925" -o "3_21531925_DSM.tif"
```

Figure XV -Command line script for sixth step

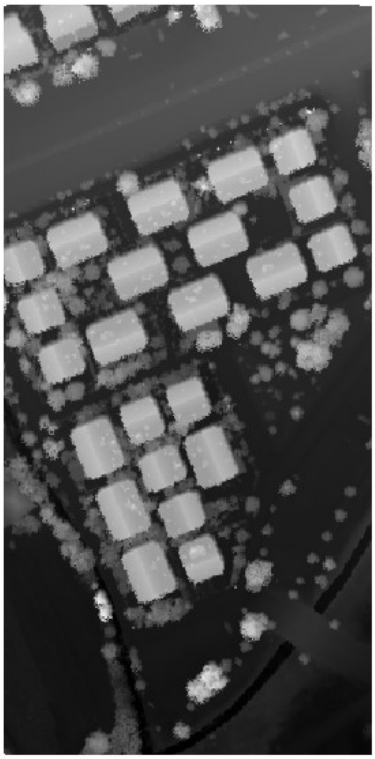

Figure XVI -Digital Surface Model Screenshots

7. nDSM generation

For this step , I used QGIS

What is nDSM?

- Top surface visible from above
- Includes – Vegetation (forests, trees,shrubs, crops, etc.) – Buildings
- Normalized DSM (nDSM)

nDSM = DSM – DTM

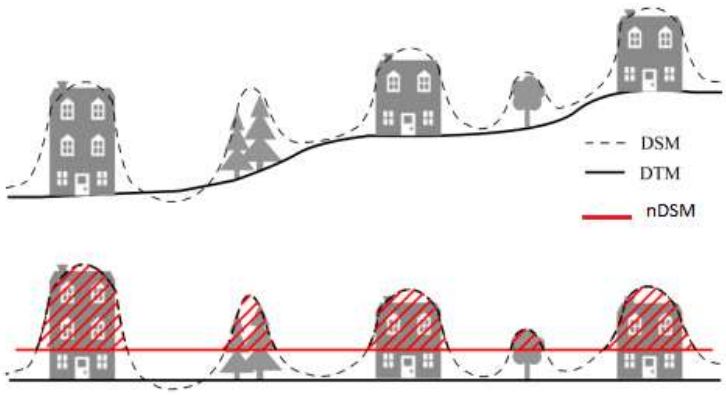

Figure XVII –What is nDSM?

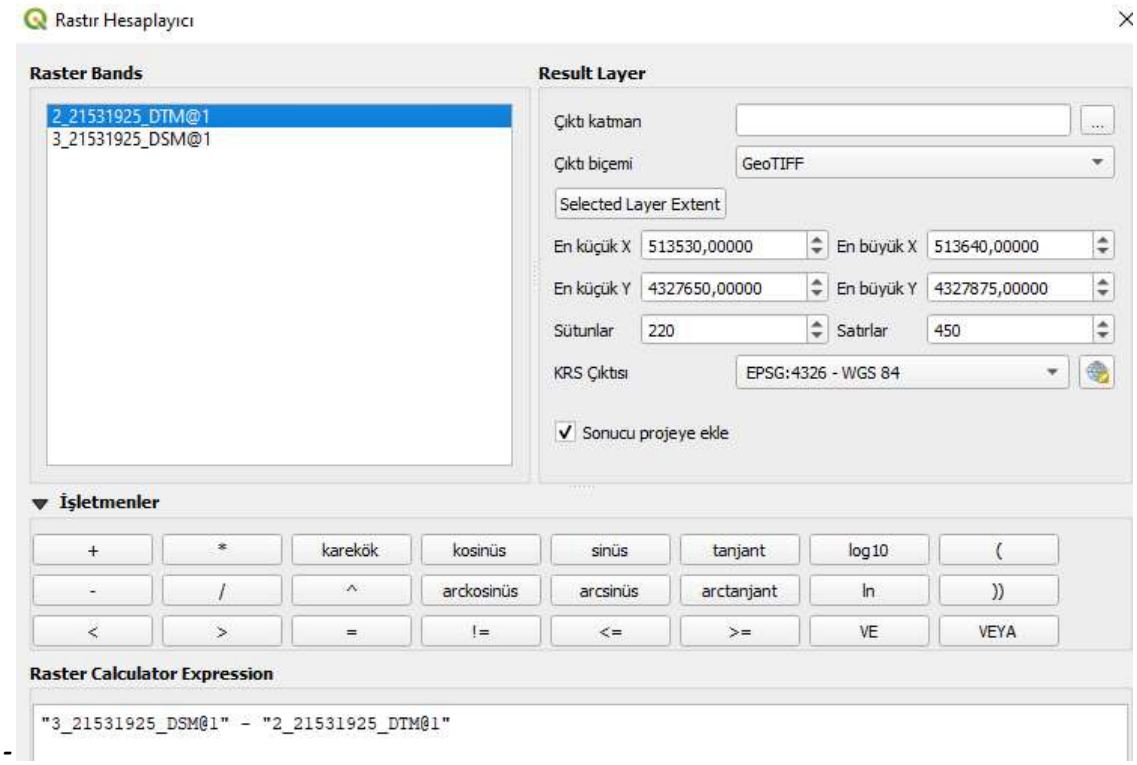

Figure XVIII - Raster Calculator in Qgis for nDSM generation Screenshot

For this step , I was worked on Qgis and I used raster calculator.Like we learned, if we find differences between DSM and DTM , we obtained nDSM.

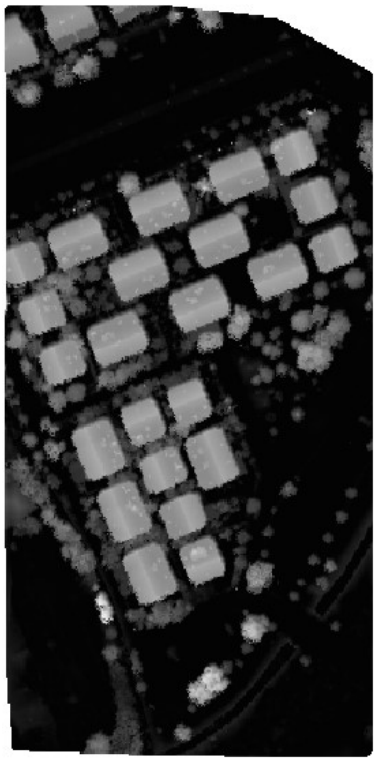

Figure XIX - Normalized Digital Surface Model screenshot

8. Building Segmentation

Same in the previous step , I used Qgis's raster calculator.My input's were my nDSMmodel. I choosed threshold value for buildings.For optimal threshold value , I tried four number.
When threshold value is 5, all buildings shows but at the same time shows trees.
When threshold value is 7 , all buildings shows and decreasing trees.
When threshold value is 8 , buildings exposed to data loss and final trial , If threshold value is 10 , almost all building disappear.

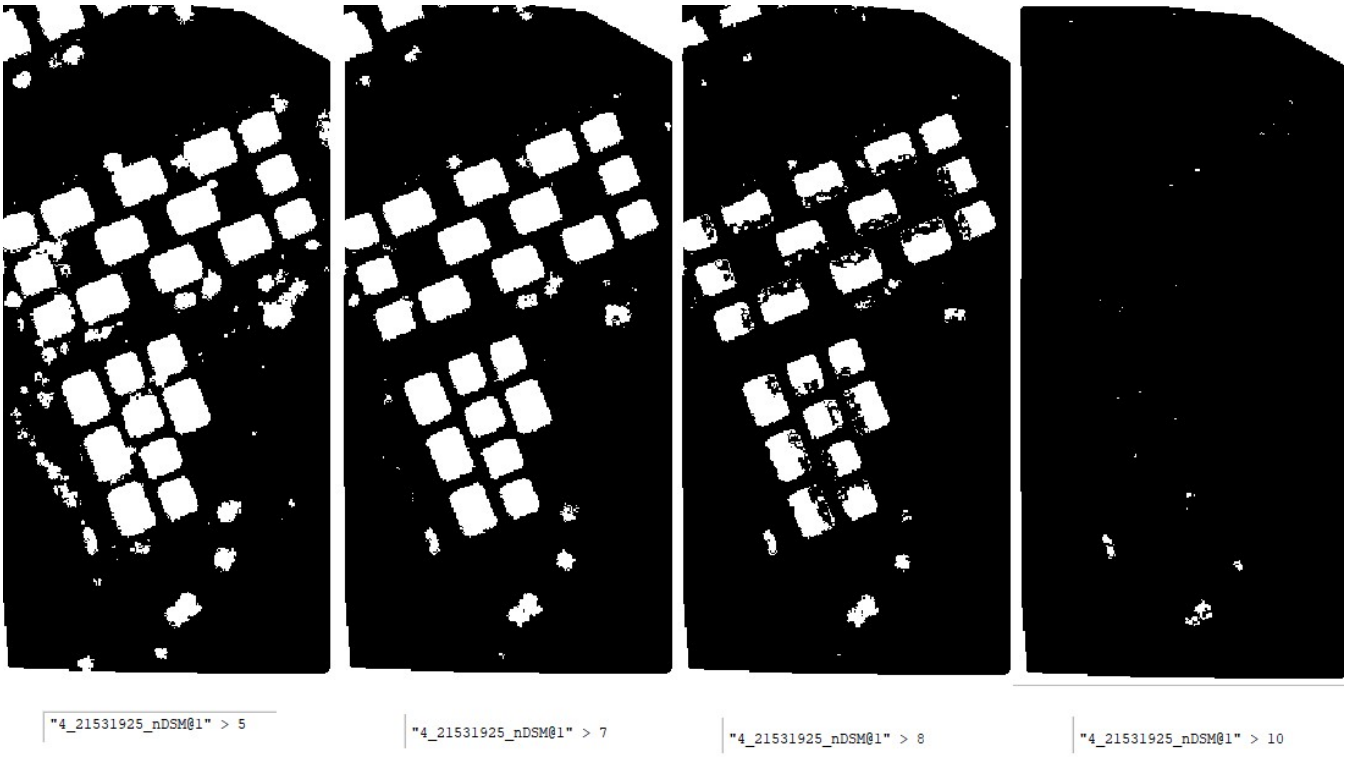

Figure XX - Screenshots for every different threshold value (I paste threshold value screenshots on Qgis at bottom)

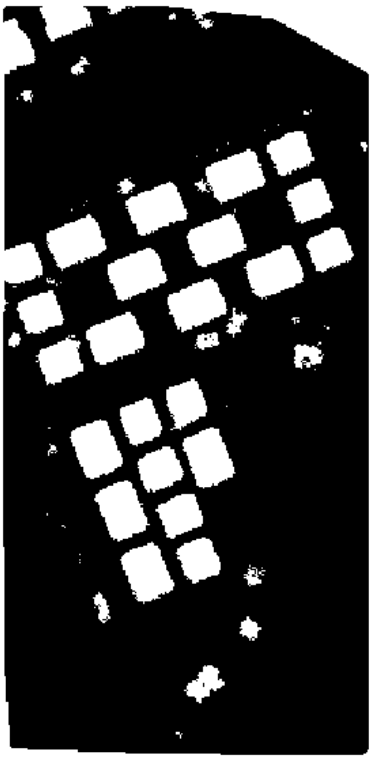

Figure XXI -Screenshot form my choice (thresholdvalue=7)

9. Building Boundary Delineation

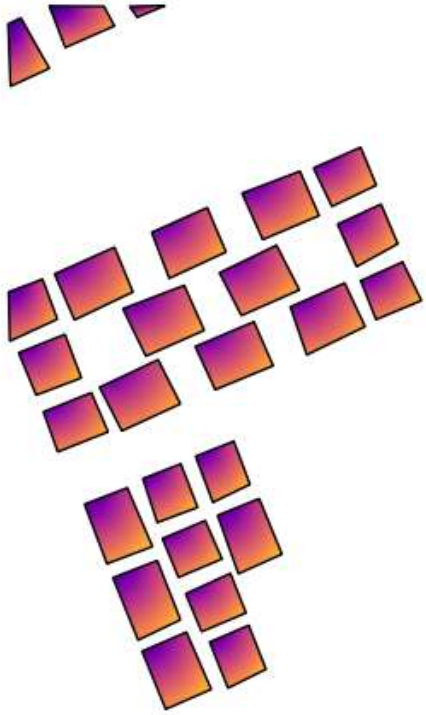

Figure XXII – Screenshots for manually building delineation

For this step , I used Qgis and nDSM with determined threshold value and manually I drawed buildings with create polygon tool.

10. BONUS

For this part , I used las2las , cloud compare and Qgis.Firstly, with keep classification filter , I obtained all points classified as building in las format.Later , I used cloud compare and convert las to shp.At the and on Qgis, I put my manually building delineation shp file and las2las output.

```
las2las -i "C:\Users\aysim\OneDrive\Masa³st³\Aysima21531925\21531925_classified.las" -
keep_classification 6 -odir "C:\Users\aysim\OneDrive\Masa³st³\Aysima21531925" -o "buil
ding_class.las"
```

Figure XXIII- Command line script for bonus step

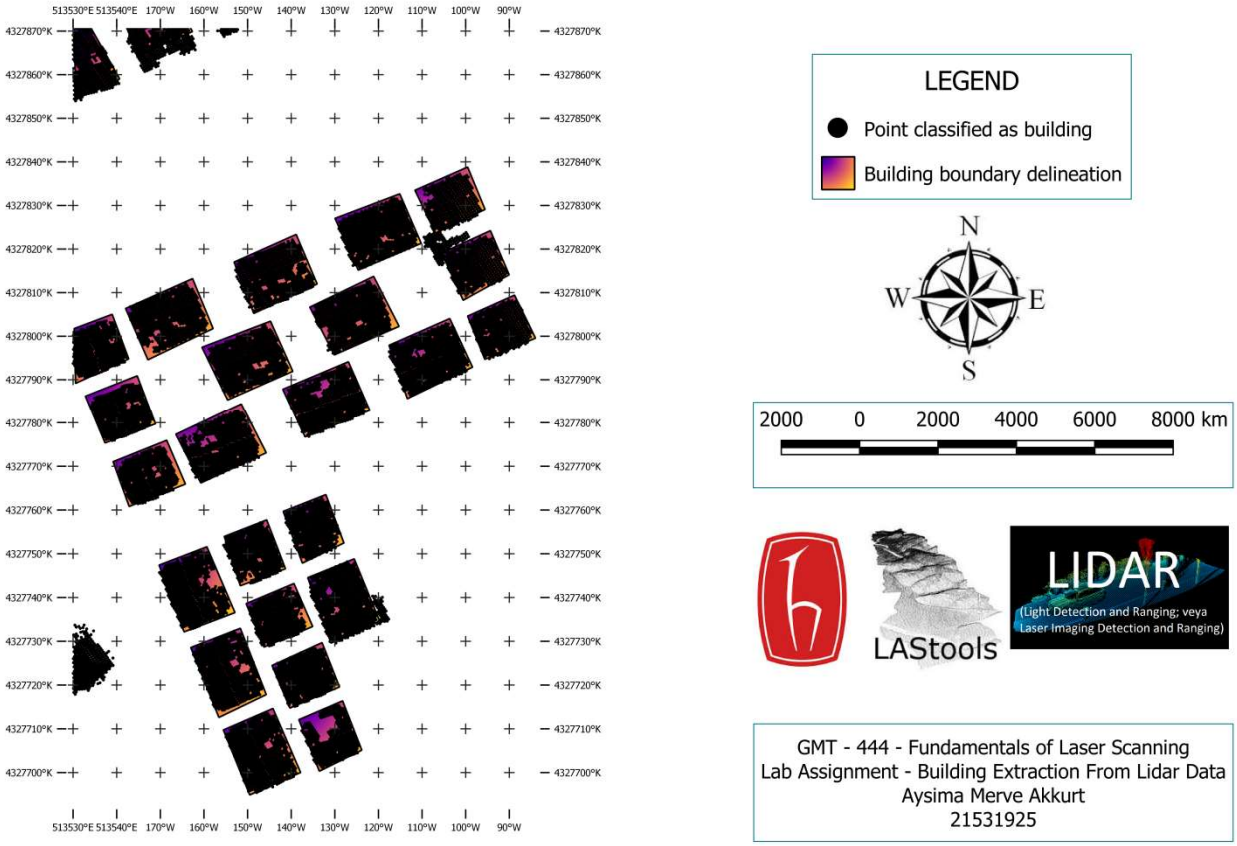

Figure XXIV-Map of comparison of Points classified as building and Building boundary delineation

As a result ,
Automatic classification of buildings not absolutely true but has a good percentage of success.The biggest shortfall, when the side walls of buildings are visible , program considers it a building.

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